

1
2 **In the Claims**

3 Claims 1, 6, 9, 11, 14-17, 22-26, and 28 are currently amended.

4 Claims 12, 13, 18-21, 30, and 31 are canceled without prejudice.

5 Claims 1-11, 14-17, 19-29, and 32-52 are pending and are listed below.

6
7 1. (Currently Amended) A method comprising:

8 sorting, using multiple depth buffers, depth data associated with multiple
9 transparent pixels that overlie one another to identify an individual pixel that lies
10 closest to an associated opaque pixel;

11 computing a transparency effect of the identified pixel relative to the
12 associated opaque pixel; and

13 after said computing, identifying a next closest transparent pixel relative to
14 the opaque pixel and computing, for the next closest pixel, a transparency effect
15 relative to the transparency effect that was just computed; and

16 wherein said sorting comprises flipping which of the multiple
17 buffers is considered as a destination buffer and a source buffer.

18
19 2. (Original) The method of claim 1, wherein said multiple depth
20 buffers comprise z buffers.

21
22 3. (Original) The method of claim 1, wherein said multiple depth
23 buffers comprise w buffers.

1 4. (Original) The method of claim 1, wherein said multiple depth
2 buffers comprise l/w buffers.

3
4 5. (Original) The method of claim 1, wherein said multiple depth
5 buffers comprise l/z buffers.

6
7 6. (Currently Amended) The method of claim 1, wherein said act of sorting
8 comprises:

9 identifying ~~one of the multiple buffers as a destination buffer that is both~~ both
10 readable and writable; and

11 identifying ~~another of the multiple buffers as a source buffer that is as only~~ only
12 readable; and.

13 ~~flipping which of the multiple buffers is considered as the~~ destination buffer and the source buffer during said acts of sorting,
14 ~~computing and identifying~~.

16
17 7. (Original) The method of claim 1 further comprising repeating said
18 act of identifying for any additional overlying transparent pixels.

19
20 8. (Original) A computing system configured to implement the method
21 of claim 1.

1 9. (Currently Amended) An apparatus comprising:

2 means for sorting, using multiple depth buffers, depth data associated with
3 multiple transparent pixels that overlie one another to identify an individual pixel
4 that lies closest to an associated opaque pixel;

5 means for computing a transparency effect of the identified pixel relative to
6 the associated opaque pixel; and

7 means for identifying a next closest transparent pixel relative to the opaque
8 pixel and computing, for the next closest pixel, a transparency effect relative to the
9 transparency effect that was just computed; and

10 wherein said means for sorting comprises means for flipping which
11 of the multiple buffers is considered as a destination buffer and a source
12 buffer.

13
14 10. (Original) The apparatus of claim 9, wherein said means for sorting
15 and means for identifying comprises hardware comparison logic.

16
17
18
19
20
21
22
23
24
25

11. (Currently Amended) A method comprising:

- 1 (a) rendering at least one opaque pixel that lies along a ray;
- 2 (b) identifying a transparent pixel that lies along the ray, the identified
- 3 transparent pixel being the closest transparent pixel to the opaque pixel;
- 4 (c) computing transparency effects of the identified transparent pixel
- 5 relative to the opaque pixel;
- 6 (d) if additional transparent pixels lie along the ray, identifying a next
- 7 closest transparent pixel relative to the opaque pixel and computing transparency
- 8 effects of the next closest pixel relative to the computed transparency effects of a
- 9 last computed transparent pixel; and
- 10 (e) repeating act (d) until transparency effects of all of the transparent
- 11 pixels along the ray have been computed in a back-to-front manner;
- 12 (f) wherein acts (a)-(e) are performed utilizing two physical depth
- 13 buffers for sorting depth data associated with the transparent pixels, and
- 14 wherein the two depth buffers are configured to be flipped.

17 12. (Cancelled)

19 13. (Cancelled)

21 14. (Currently Amended) The method of claim 11, wherein the
22 physical depth buffers comprise acts (a)-(e) are performed utilizing two
23 physical z buffers for sorting depth data associated with the transparent
24 pixels.

1 15. (Currently Amended) The method of claim 11, wherein the
2 physical depth buffers comprise acts (a)-(e) are performed utilizing two
3 physical w buffers for sorting depth data associated with the transparent
4 pixels.

5
6 16. (Currently Amended) The method of claim 11, wherein the
7 physical buffers comprise acts (a)-(e) are performed utilizing two physical
8 1/w buffers for sorting depth data associated with the transparent pixels.

9
10 17. (Currently Amended) The method of claim 11, wherein the
11 physical buffers comprise acts (a)-(e) are performed utilizing two physical
12 1/z buffers for sorting depth data associated with the transparent pixels.

13
14 18. (Cancelled)

15
16 19. (Cancelled)

17
18 20. (Cancelled)

19
20 21. (Cancelled)

21
22
23
24
25

1 22. (Currently Amended) The method of claim 11, ~~wherein acts (a)-(e) are~~
2 ~~performed utilizing two physical depth buffers for sorting depth data associated~~
3 ~~with the transparent pixels, and wherein performing acts (a)-(e) comprise:~~

4 designating one of the depth buffers as readable and writable;
5 designating the other of the depth buffers as readable only; and
6 flipping the designations of the depth buffers.

7
8 23. (Currently Amended) The method of claim 11, ~~wherein acts (a)-(e) are~~
9 ~~performed utilizing two physical z buffers for sorting depth data associated with~~
10 ~~the transparent pixels, and wherein the two physical depth buffers comprise z~~
11 ~~buffers and performing acts (a)-(e) comprise:~~

12 designating one of the z buffers as readable and writable;
13 designating the other of the z buffers as readable only; and
14 flipping the designations of the z buffers.

15
16 24. (Currently Amended) The method of claim 11, ~~wherein acts (a)-(e)~~
17 ~~are performed utilizing two physical w buffers for sorting depth data~~
18 ~~associated with the transparent pixels, and wherein the two physical depth~~
19 ~~buffers comprise w buffers and performing acts (a)-(e) comprise:~~

20 designating one of the w buffers as readable and writable;
21 designating the other of the w buffers as readable only; and
22 flipping the designations of the w buffers.

23
24
25

1 25. (Currently Amended) The method of claim 11, ~~wherein acts (a)-(e)~~
2 ~~are performed utilizing two physical l/w buffers for sorting depth data~~
3 ~~associated with the transparent pixels, and wherein the two physical depth~~
4 ~~buffers comprise l/w buffers and~~ performing acts (a)-(e) comprise:

5 designating one of the l/w buffers as readable and writable;
6 designating the other of the l/w buffers as readable only; and
7 flipping the designations of the l/w buffers.

8
9 26. (Currently Amended) The method of claim 11, ~~wherein acts (a)-(e)~~
10 ~~are performed utilizing two physical l/z buffers for sorting depth data~~
11 ~~associated with the transparent pixels, and wherein the two physical depth~~
12 ~~buffers comprise l/z buffers and~~ performing acts (a)-(e) comprise:

13 designating one of the l/z buffers as readable and writable;
14 designating the other of the l/z buffers as readable only; and
15 flipping the designations of the l/z buffers.

16
17 27. (Original) A computing system configured to implement the
18 method of claim 11.

1 28. (Currently Amended) A system comprising:
2 means for rendering at least one opaque pixel that lies along a ray;
3 means for identifying a transparent pixel that lies along the ray, the
4 identified transparent pixel being the closest transparent pixel to the opaque pixel;
5 means for computing transparency effects of the identified transparent pixel
6 relative to the opaque pixel; and
7 means for identifying, in a back-to-front manner, additional
8 transparent pixels and successively computing transparency effects for the
9 additional transparent pixels, wherein said means for identifying comprises
10 a pair of physical depth buffers that can be logically flipped.

11
12 29. (Original) The system of claim 28, wherein said means for
13 rendering comprises a graphics subsystem.

14
15 30. (Cancelled)

16
17 31. (Cancelled)

18
19
20
21
22
23
24
25

1 32. (Original) A system comprising:

2 a transparent depth sorting component comprising:

3 at least two physical depth buffers;

4 a writeback counter to count writebacks that occur to at least
5 one of the two physical depth buffers; and

6 comparison logic that is configured to effect:

7 sorting, using said at least two physical buffers, of
8 depth data associated with multiple transparent pixels that
9 overlie one another to identify an individual pixel that lies
10 closest to an associated opaque pixel;

11 computing a transparency effect of the identified pixel
12 relative to the associated opaque pixel;

13 after said computing, identifying a next closest
14 transparent pixel relative to the opaque pixel; and

15 computing, for the next closest pixel, a transparency
16 effect relative to the transparency effect that was computed
17 for the said closest individual pixel and the associated
18 opaque pixel.

1 33. (Original) The system of claim 32, wherein:

2 one of said at least two physical depth buffers is capable of being
3 designated as readable and writable;

4 another of said at least two physical depth buffers is capable of
5 being designated as readable only; and

6 designations of said at least two physical depth buffers are capable
7 of being flipped.

8

9 34. (Original) The system of claim 32, wherein said at least two
10 physical depth buffers comprise z buffers.

11

12 35. (Original) The system of claim 32, wherein said at least two
13 physical depth buffers comprise w buffers.

14

15 36. (Original) The system of claim 32, wherein said at least two
16 physical depth buffers comprise 1/w buffers.

17

18 37. (Original) The system of claim 32, wherein said at least two
19 physical depth buffers comprise 1/z buffers.

20

21 38. (Original) The system of claim 32, wherein said transparent depth
22 sorting component is configured to terminate transparent depth sorting
23 when the writeback counter indicates that no writebacks have occurred.

1 39. (Original) A graphics subsystem embodying the transparent depth
2 sorting component of claim 32.

3

4 40. (Original) A computer system embodying the graphics subsystem
5 of claim 39.

6

7 41. (Original) A method comprising:

8 mapping a first of two depth buffers as a destination buffer that is
9 readable and writable, a second of the two depth buffers being designated
10 as a source buffer that is only readable;

11 rendering one or more opaque objects having associated opaque
12 pixels;

13 writing a depth value associated with an opaque pixel to the first
14 buffer;

15 mapping the second of the depth buffers as the destination buffer,
16 the first of the depth buffers being designated as the source buffer;

17 initializing the destination buffer to a predetermined value;

18 effecting a comparison of a new pixel depth value with values in the
19 source and destination buffers and writing the new pixel depth value to the
20 destination buffer if the new pixel depth value is (a) greater than the value
21 currently in the destination buffer and (b) less than the value in the source
22 buffer, effective to write a new pixel depth value that is associated with a
23 pixel that is closest to a pixel whose depth value is contained in the source
24 buffer;

25 rendering one or more transparent objects having associated

1 transparent pixels;

2 determining if transparency effects for all transparent pixels in all
3 transparent objects have been accounted for and if so, terminating
4 processing and, if not:

5 mapping the first of the depth buffers as the destination
6 buffer, the second of the buffers being designated as the source
7 buffer;

8 effecting a comparison of the new pixel depth value with
9 values in the source and destination buffers and writing to a frame
10 buffer and the destination buffer if the new pixel depth value is
11 equal to the value in the source buffer and the new pixel depth
12 value is less than the value in the destination buffer;

13 rendering one or more transparent objects; and

14 returning to said act of mapping the second of the depth
15 buffers until transparency effects of all transparent pixels in all the
16 transparent objects have been accounted for.

17
18 42. (Original) The method of claim 41, wherein said predetermined
19 value comprises a depth buffer's smallest value.

20
21 43. (Original) The method of claim 41, wherein said act of determining
22 is performed by maintaining a depth buffer writeback counter that keeps
23 track of depth buffer writebacks.

24

25

1 44. (Original) The method of claim 41, wherein the depth buffers
2 comprise z buffers.

3
4 45. (Original) The method of claim 41, wherein the depth buffers
5 comprise w buffers.

6
7 46. (Original) The method of claim 41, wherein the depth buffers
8 comprise l/w buffers.

9
10 47. (Original) The method of claim 41, wherein the depth buffers
11 comprise l/z buffers.

12
13 48. (Original) A computing system configured to implement the
14 method of claim 41.

15
16 49. (Original) A system comprising:
17 a processor;
18 at least two depth buffers;
19 a frame buffer; and
20 a graphics subsystem operably connected with the processor and
21 configured to, under the influence of the processor:

22

23

24

25

1 map a first of the depth buffers as a destination buffer that is
2 readable and writable, a second of the depth buffers being
3 designated as a source buffer that is only readable;

4 render one or more opaque objects having associated opaque
5 pixels;

6 write a depth value associated with an opaque pixel to the
7 first buffer;

8 map the second of the depth buffers as the destination buffer,
9 the first of the depth buffers being designated as the source buffer;

10 initialize the destination buffer to a predetermined value;

11 effect a comparison of a new pixel depth value with values in
12 the source and destination buffers and write the new pixel depth
13 value to the destination buffer if the new pixel depth value is (a)
14 greater than the value currently in the destination buffer and (b) less
15 than the value in the source buffer, effective to write a new pixel
16 depth value that is associated with a pixel that is closest to a pixel
17 whose depth value is contained in the source buffer;

18 render one or more transparent objects having associated
19 transparent pixels;

20 determine if transparency effects for all transparent pixels in
21 all the transparent objects have been accounted for and if so,
22 terminate processing and, if not:

23 map the first of the depth buffers as the destination
24 buffer, the second of the buffers being designated as the
25 source buffer;

effect a comparison of the new pixel depth value with values in the source and destination buffers and write to the frame buffer and the destination buffer if the new pixel depth value is equal to the value in the source buffer and the new pixel depth value is less than the value in the destination buffer:

render one or more transparent objects; and

return to said mapping the second of the depth buffers until transparency effects of all transparent pixels in all the transparent objects have been accounted for.

50. (Original) The system of claim 49, wherein said predetermined value comprises a depth buffer's smallest value.

51. (Original) The system of claim 49 further comprising a depth buffer writeback counter that keeps track of depth buffer writebacks.

52. (Original) The system of claim 49, wherein the depth buffers comprise z buffers.